Integration

Subroutine ASIMPSON

¤ Purpose

This subroutine numerically integrates a user-defined analytic function of the form $y = f(x)$ using an *adaptive Simpson* solution method.

¤ Syntax

```
SUB ASIMPSON (A, B, ACC, SUM, ESTERR, IFLAG)
```

¤ Where

```
A      = lower integration limit [input]
B      = upper integration limit [input]
ACC    = solution accuracy [input]
SUM    = integral form A to B [output]
ESTERR = relative error [output]
IFLAG  = error flag [output]
         1 = no error
         2 = more than 30 levels
         3 = subinterval too small
         4 = more than 2000 evaluations
```

¤ Comments

This BASIC subroutine numerically integrates a user-defined analytic function as follows

$$S(x) = \int_{A}^{B} f(x)\,dx$$

over the lower and upper limits *A* and *B* specified by the user. This numerical method is based on the adaptive Simpson algorithm described in Chapter 2 and Part V of Reference 14.

The analytic function must be coded by the user in a subroutine called USERFUNC with the following syntax:

```
SUB USERFUNC(X, FVAL)
```

In the parameter list, X is the function argument and FVAL is the function value at X.
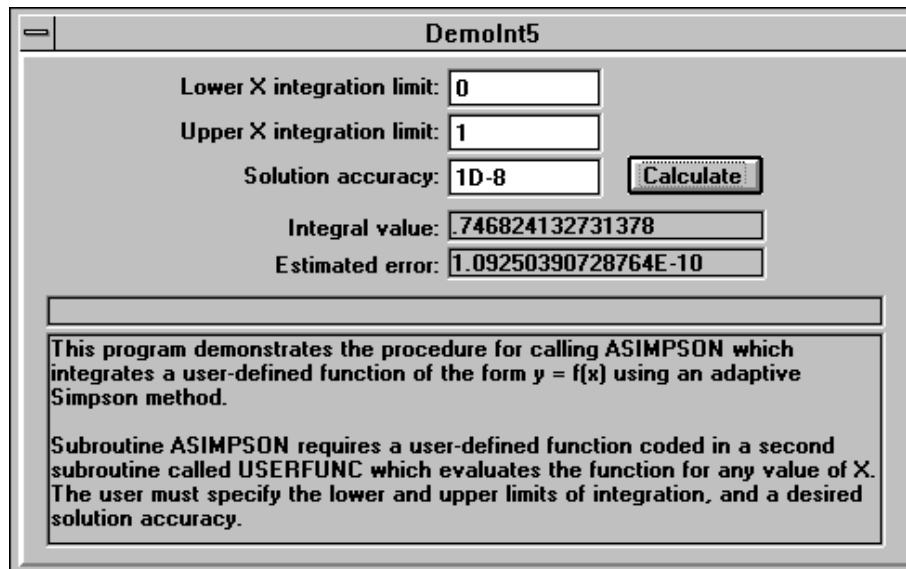
Subroutine ASIMPSON (continued)

The companion demonstration program `DEMOINT5` numerically integrates the following function

$$y = f(x) = e^{-x^2}$$

over a lower and upper integration limit specified by the user. A BASIC subroutine defining this function is stored on the BNALib diskette in the file `USERFUN1.BAS`. The source code is as follows:

```
Sub USERFUNC (X, FVAL)
    ' User function subroutine
    ' f(x) = e^(-x^2)
    ' Input
    '  X = function argument
    ' Output
    '  FVAL = function value = f(X)
    FVAL = Exp(-X * X)
End Sub
```

The following is a typical screen display generated by the Visual Basic version of the `DEMOINT5` software.


```
┌─────────────────────────────────────────────────────────────┐
│ ▭│                      DemoInt5                              │
├─────────────────────────────────────────────────────────────┤
│            Lower X integration limit: │0              │       │
│            Upper X integration limit: │1              │       │
│               Solution accuracy: │1D-8          │ │Calculate│ │
│                 Integral value: │.746824132731378        │   │
│                 Estimated error: │1.09250390728764E-10    │   │
│  ┌────────────────────────────────────────────────────────┐  │
│  └────────────────────────────────────────────────────────┘  │
│  ┌────────────────────────────────────────────────────────┐  │
│  │This program demonstrates the procedure for calling ASIMPSON which │
│  │integrates a user-defined function of the form y = f(x) using an adaptive │
│  │Simpson method.                                          │  │
│  │                                                          │  │
│  │Subroutine ASIMPSON requires a user-defined function coded in a second │
│  │subroutine called USERFUNC which evaluates the function for any value of X. │
│  │The user must specify the lower and upper limits of integration, and a desired │
│  │solution accuracy.                                       │  │
│  └────────────────────────────────────────────────────────┘  │
└─────────────────────────────────────────────────────────────┘
```